TOTAL MAXIMUM DAILY LOAD (TMDL)

In

Suwannee River Basin

(Includes TMDLs for Fecal Coliform in Camp Branch and Falling Creek)

Hamilton and Columbia Counties, Florida

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LIST OF ABBREVIATIONS

BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
Rf3	Reach File 3
RM	River Mile
SRWMD	Suwannee River Water Management District
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: Florida
County: Hamilton and Columbia
Major River Basin: Suwannee River Basin (HUC 03110201)

Impaired Waterbodies (1998 303(d) List):

WBID	Segment Name	Constituent(s)
3477	Falling Creek	Fecal Coliform
3401	Camp Branch	Fecal Coliform

2. TMDL Endpoints (i.e., Targets)

Fecal Coliform: 400 counts/100mL

3. Fecal Coliform Allocation (counts/day):

WBID	WLA	LA	TMDL	Reduction
3477	NA[1]	$9.40x\ 10^{9}$	$9.40x\ 10^{9}$	40 %
3401	NA	40 % reduction (See note 2)	81 % reduction (See note 2)	81 %

Notes:
1. NA is not applicable as there are not point source discharges of fecal coliform in the watershed.
2. TMDL and LA for Camp Branch (WBID 3401) expressed as percent reduction of instream concentration necessary to achieve the target concentration (i.e., 400 counts/100ml).

4. Public Notice Date:

5. Submittal Date:

6. Establishment Date:

7. **Endangered Species (yes or blank):** yes

8. **EPA Lead on TMDL (EPA or blank):** EPA

9. **TMDL Considers Point Source, Nonpoint Source, or both:** Nonpoint Sources are only contributors of fecal coliform in the watersheds.

10. Major NPDES Discharges to surface waters: None

TOTAL MAXIMUM DAILY LOAD (TMDL)
SUWANNEE RIVER BASIN (HUC 03110201)

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Suwannee Basin is a group 1 basin, first assessed in 2000 with plans to revisit water management issues in 2005. FDEP established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. The Suwannee Basin is in the Suwannee River Water Management District (SRWMD).

For the purpose of planning and management, SRWMD divided the Suwannee Basin into 16 planning units. A planning unit is either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided into "water gment usually contains only one unique waterbody type (stream, lake, cannel, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. Camp Branch and Falling Creek are both within the Upper Suwannee River Planning Unit.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified numerous WBIDs in the Suwannee Basin as not supporting water quality standards (WQS). After assessing all readily available water quality data, EPA is responsible for developing TMDLs in Camp Branch (WBID 3401) and Falling Creek (WBID 3477). Fecal coliform is the pollutants of concern addressed in these TMDLs.

The TMDLs addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

Camp Branch and Falling Creek are designated as Class III waters having a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The level of impairment is denoted as threaten, partially or not supporting designated uses. A stream that is classified as threaten currently meets WQS but trends indicate the designated use may not be met in the next listing cycle. A stream classified as partially supporting designated uses is defined as somewhat impacted by pollution and water quality criteria are exceeded on some frequency. For this category, water quality is considered moderately impacted. A stream that is categorized as not supporting is highly impacted by pollution and water quality criteria are exceeded on a regular or frequent basis. On these streams, water quality is considered severely impacted.

The format of the remainder of this report is as follows: Chapter 3 is a general description of the Falling Creek and Camp Branch watersheds; Chapter 4 describes the water quality standard and target criteria for the TMDLs; and Chapter 5 describes the development of the fecal coliform TMDLs.

3. WATERSHED DESCRIPTION

The Suwannee Basin covers 7,702 square miles in north central Florida. Portions of the basin also extend into southern Georgia. Falling Creek and Camp Branch are located in Columbia and Hamilton counties, respectively (see Figure 1). Both streams discharge to the Suwannee River, the second largest river in the state in terms of flow. USGS Hydrologic Unit Code (HUC) 03110201 defines the basin watershed. The following description of the Upper Suwannee River Planning Unit is from the Suwannee Basin Status Report (FDEP, 2001). This document should be consulted for additional details on the basin.

The Upper Suwannee River watershed drains about 2,643 square miles in southern Georgia and northern Florida. Sixty-five percent of the watershed lies in Georgia. Forested areas cover almost 53 percent and wetlands nearly 26 percent of the planning unit. Silviculture is the dominate land activity in most of the Suwannee Basin's forested and portions of wetland areas. Land cover within the Falling Creek and Camp Branch watersheds is provided in Table 1. The basis of the land cover data is 1994-95 coverage prepared by the SRWMD (1998). The largest area designated as urban and built-up in the center of the planning unit is actually an open-pit phosphate mine, owned and operated by PCS Phosphate, formerly known as Occidental. Agricultural lands border the Suwannee River and occupy slightly more than 10 percent of the watershed.

Table 1. Land Use Classification in Falling Creek and Camp Branch WBIDs (SRWMD, 1998)

Land Use Category	**Falling Creek (WBID 3477)**		**Camp Branch (WBID 3401)**	
	Area (acres)	Percentage	Area (acres)	Percentage
Urban and Built-up	306.9	2.1	55.4	1.0
Agricultural	277.5	1.9	442.1	8.0
Rangeland	157.7	1.1	41.8	0.8
Forest	10,675	73.1	2,394	43.5
Water	18.7	0.1	4.5	0.1

Land Use Category	**Falling Creek (WBID 3477)**		**Camp Branch (WBID 3401)**	
	Area (acres)	Percentage	Area (acres)	Percentage
Wetlands	3,020	20.7	261	4.7
Barren Land	25.1	0.2	2,192	39.8
Transportation and Utilities	92	0.6	109	2.0
Commercial, Industry, and Public	22	0.2	6.5	0.1
Total	14,595		5,507	

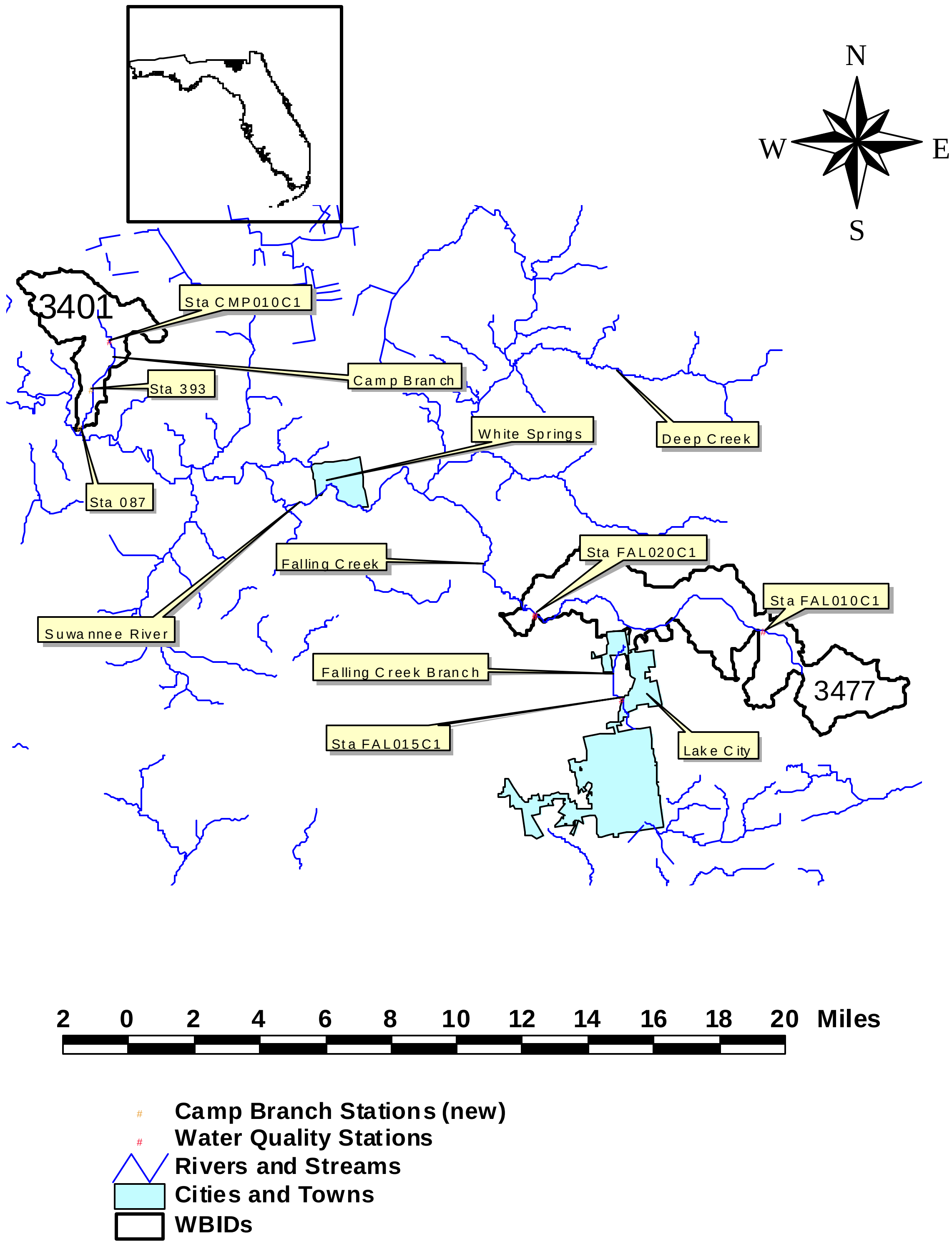


Figure 1. Location of Falling Creek and Camp Branch watersheds

4. WATER QUALITY STANDARD

Falling Creek and Camp Branch are classified as Class III waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The criteria for fecal coliform bacteria are as follows:

Fecal Coliform Bacteria

The most probable number (MPN) or membrane filter (MF) counts per 100 ml of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

5. FECAL COLIFORM TMDLS

This section of the report details the development of fecal coliform TMDLs in Camp Branch (WBID 3401) and Falling Creek (WBID 3477). Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals.

5.1 Water Quality Assessment and Deviation From Target

FDEP and the Suwannee River Basin Water Management District maintain ambient monitoring stations throughout the basin. Monitoring stations used to develop the TMDLs are shown in Table 2. Table 3 provides a statistical summary of the data and includes the percent of samples that deviate from the target. A listing of all monitoring stations, measured coliform concentrations, and graphics showing the data with respect to the target are in APPENDIX A.

Table 2. Monitoring Stations used in the Development of Fecal Coliform TMDLs

WBID	Name	Station Name	Available Sampling Period	Number Samples
3477	Falling Creek	21FLSUW FAL020C1	2/7/89 – 5/21/02	60
3401	Camp Branch	21FLSUW CMP010C1	2/8/89 – 7/30/03	25
		21FLWQA 302213908253087	6/4/02 – 6/18/02	2
		21FLWQA 302311808252393	6/4/02 – 6/18/02	2
		21FLA 21010054	8/1/01 – 9/12/01	2

Table 3. Summary of Fecal Coliform Monitoring Data since 1995

WBID	30-Day Geometric Mean[1]	# Samples > 400 (counts/100mL)	# Samples > 800 (counts/100ml)	Minimum Concentration (counts/100ml)	Maximum Concentration (counts/100ml)
3477	N/A	9	2	1	1850
3401	N/A	3	3	19	2950

Notes:

1. N/A = not applicable as less than 10 samples collected within a 30-day period to evaluate this criteria.

In addition to collecting fecal coliform data, the samples were also analyzed for fecal streptococci (FS). Streptococci bacteria originate from humans and domesticated animals (e.g., cattle and horses). The ratio of fecal coliform (FC) to FS has been used to determine whether contamination is due to human or animal sources (Chapra, 1997). In general a FC/FS greater than 4 is often taken to indicate human contamination whereas a FC/FS less than 1 is interpreted as originating from other warm-blooded animals. As discussed in Chapra, this ratio should be used with care because of differential die-off of FC and FS. In generally, the FC/FS ratio is less than 1 based on available samples collected in Camp Branch and Falling Creek (see APPENDIX A).

5.2 Source Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired watersheds. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

5.2.1 Point Sources

There are no NPDES facilities discharging fecal coliform bacteria to surface waters in the Camp Branch or Falling Creek watersheds. PCS Phosphate (FL0000655) is located in the headwaters of Camp Branch and is permitted to discharge industrial wastewater. PCS Phosphate is not required to monitor for fecal coliform bacteria. The discharge location for this facility is in WBID 3381.

5.2.2 Non-point Sources

5.2.2.1 Wildlife

Wildlife deposit bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams. The bacteria load from wildlife is assumed background, as the contribution from this source is small relative to the load from urban and agricultural areas. In addition, any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

5.2.2.2 Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams. Agricultural activities including runoff from pastureland and cattle in streams impact water quality. Livestock data from the 1997 Census of Agriculture for the counties encompassing the impaired WBIDs are listed in Table 4. Cattle, including beef, is the predominate livestock Columbia County. In Hamilton County, poultry represents a significant portion of the livestock. Confined Animal Feeding Operations (CAFOs) are not known to operate in either the Falling Creek or Camp Branch WBIDs. The U.S. Department of Agriculture (USDA) is currently in the process of updating the agricultural census for 2002. Data from the 2002 Census will be released in Spring 2004.

Table 4. Livestock Distribution by County (source: NASS, 1977)

Livestock (inventory)	Columbia	Hamilton
Cattle and calves	11,054	5,125
Beef Cows	13,321	(D)
Dairy Cows	207	(D)
Swine	1,828	6.456
Poultry (broilers sold)	(D)[1]	1,563,980
Sheep	16	64
Horses and Ponies	428	158

Notes: (D) – data withheld to avoid disclosing data for individual farms

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Septic tanks are the predominant method of domestic waste disposal in the Suwannee River Basin. Because the population density in the basin is low, septic tanks are not a significant source of concern, except in a few high-density subdivisions (less than five acres per home site) along the edge of certain rivers and streams. The effluent from a well-functioning septic tank is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, septic tanks can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

5.2.2.4 Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (FS), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, Florida Administrative Code (F.A.C.).

The Surface Water Improvement and Management Program (SWIM) was enacted in 1987 (Section 373.451, FS) as a mechanisms for managing waterbodies as entire systems. The SWIM program focuses on issues of water quality and water resource preservation. SWIM management plans have been developed for the watersheds of six waterbodies in the basin: Suwannee River, Sante Fe River, Alligator Lake, Coastal Rivers, Aucilla River, and Waccasassa River. Preservation is emphasized in the SWIM plans so that water quality problems can be anticipated and prevented. Restoration is an emphasis in Alligator Lake as this waterbody already suffers from degraded water quality and habitat.

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

5.3 Analytical Approach

5.3.1 TMDL Methodology

The analytical approach for coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. The reduction is based on instream samples violating the water quality criteria and the target concentration. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. The approach used to develop the coliform TMDLs are listed in Table 5.

Table 5. Approach used to develop coliform TMDLs in Suwannee Basin

Listed Waterbody	Parameter	Approach
Falling Creek (3477)	Fecal Coliform	Load duration curve
Camp Branch (3401)	Fecal Coliform	Percent reduction

In the load duration curve approach, existing and TMDL values are calculated as the average value between the 10^{th} and 90^{th} interval of flow, and based on these values, a percent reduction required to achieve water quality standards is calculated. Samples with concentrations exceeding the water quality criteria are used to characterize the "worst case" scenario for existing conditions. The allowable load, or TMDL value, is calculated using the applicable water quality criteria. Loads are calculated based on the conservation of mass principal as defined in the following equation.

Load = Concentration * Flow * Conversion Factor

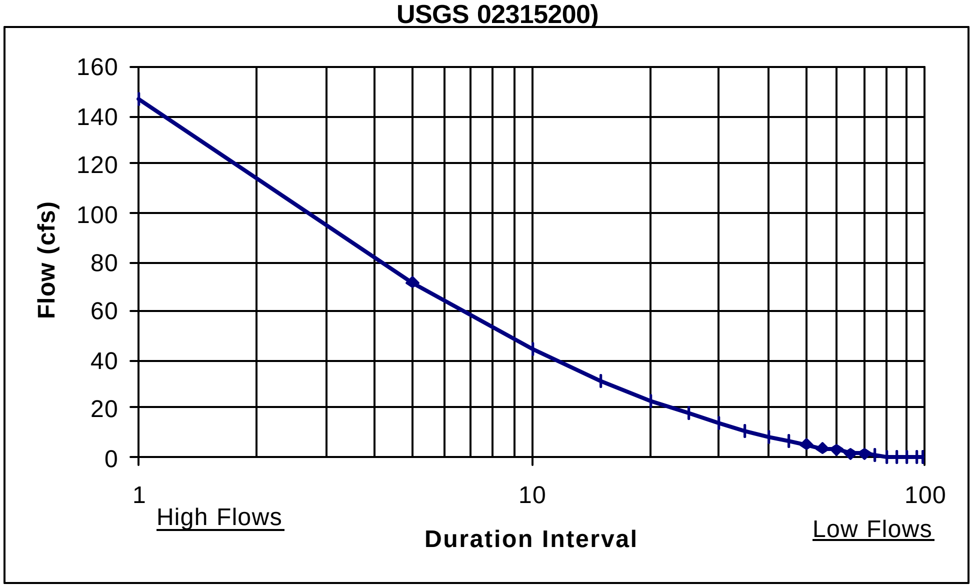
Where: Load = counts/day
Flow = cfs
Concentration = counts/100mL
Conversion Factor =(28.247L/cf*86400sec/day* 1000mL/L)/100mL

For existing conditions, the sample concentration and an estimate of flow on the day of sampling is used to calculate the load. The applicable water quality criterion is the concentration used to calculate the allowable load. A continuous flow gage does not operate in the Falling Creek watershed; however, a gage was operational on Deep Creek from 1979 through 1998. Deep Creek is located in the same Hydrologic Unit Code (HUC) as Falling Creek (HUC 03110201) and both have similar hydrologic characteristics (e.g., both are blackwater streams, and have similar slope and landuse). Flow at the time of sampling is estimated based on the drainage area ratio between Falling Creek (drainage area approximately 23 sq. miles) and the continuous gage on Deep Creek (drainage area approximately 88.6 sq. miles). In accordance with USGS protocols, the drainage area method can be used to estimate flows when the drainage area for the ungage site is within about 0.5 to 1.5 times the drainage area of the gaged site (personal communications, USGS, 2002).

5.3.2 Flow Duration Curves

The first step in developing load duration curves is to create flow duration curves. A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. The curve relates flows measured at a monitoring station to a duration interval representing the percent of time flows are equaled or exceeded. Flows are ranked from low, which are exceeded nearly 100 percent of the time, to high, which are exceeded less than 1 percent of the time. Flow duration curves are limited to the period of record available at a gage. The confidence in the duration curve approach in predicting realistic percent load reductions increases when longer periods of record are used to generate the curves. The flow duration curve for Falling Creek is shown in Figure 2.

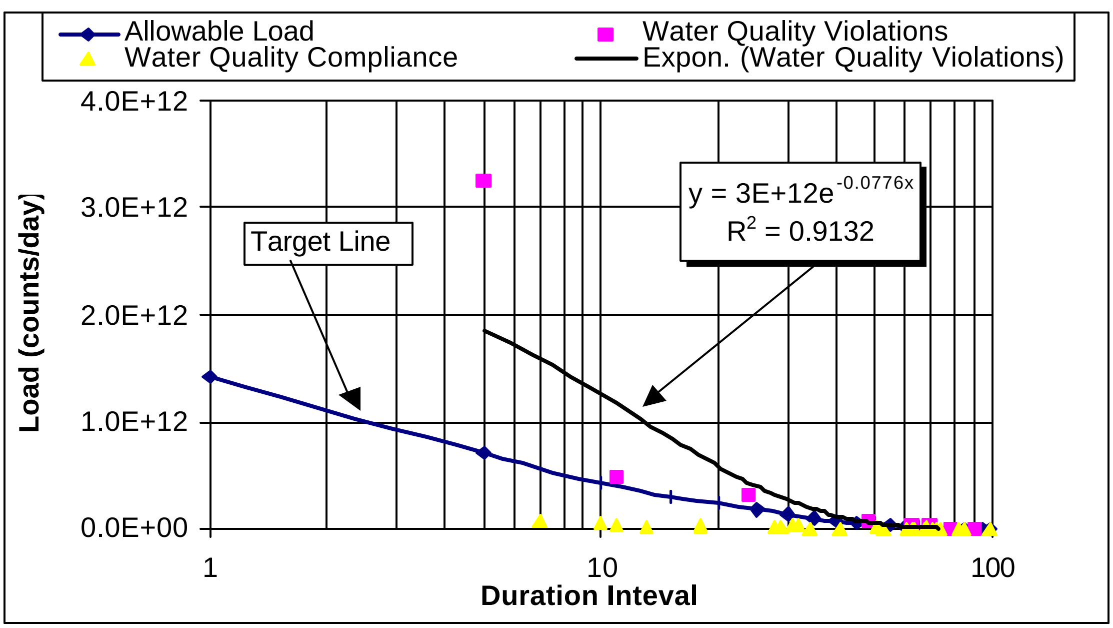
Figure 2. Flow Duration Curve for Falling Creek (based on flows at Deep Creek gage, USGS 02315200)



5.3.3 Load Duration Curves

Flow duration curves are transformed into load duration curves by multiplying the flow values at each duration interval by the appropriate water quality criterion and a conversion factor. The line through these points is called the target line. The 400 criterion is used in the target load calculation. Each point on the target line represents the allowable load, or TMDL, at each interval. Existing loads are superimposed on the curve based on the duration interval of the flow used to calculate the existing load. Loads that plot above the target line indicate a violation of the water quality criterion, while loads plotting below the line represent compliance. The load duration curve for fecal coliform in Falling Creek is shown in Figure 3.

Figure 3. Load Duration Curve for Fecal Coliform in Falling Creek (WBID 3477)



The positioning of monitoring data on the load duration curve provides an indication of the potential sources and delivery mechanisms of the pollutant. In general, violations occurring on the right side of the curve typically occur during low flow events and are indicative of continuous pollutant sources, such as NPDES permitted discharges, leaking collection lines, or leaking septic systems. Livestock having access to streams could also be a source during low flow (livestock are not expected to be in the stream during high flows). Violations that occur on the left side of the curve occur during high flow events. Violations in this range are indicative of sources responding to rainfall events. As shown in Figure 3, water quality violations occur during all flow events. Potential sources in this range are in response to rainfall events when surface runoff and infiltration/interflow dominate or direct inputs such as cattle in stream or leaking septic tanks.

A trend line is drawn through the data points representing water quality violations. In the load curve application, trend lines are used to predict the load at other duration intervals. The type of line drawn through the data can have several shapes, ranging from linear (simplest form) to moving average. The type of the line chosen should best mimic the target line and result in a relatively high correlation factor, denoted by the variable R^2. The correlation factor provides an indication of how well the equation of the line represents the data. In general, high correlation factors are not associated with environmental data.

5.4 Development of Total Maximum Daily Loads

5.4.1 Regulatory Requirements

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or <u>other appropriate measure</u>. TMDLs for the impaired waterbodies are expressed in terms of a percent reduction, and where possible, as loads in units of counts per day. When expressed as a load, the TMDL value represents the maximum one-day load the stream can transport over a 30-day period and maintain the water quality standards.

The target for the coliform TMDLs is the acute criteria. It is appropriate to base the TMDL on the acute criteria as the source assessments did not reveal any point or nonpoint sources that continuously discharge into the streams that cause or contribute to the waterbodies not meeting coliform standards. Additionally, violations of the acute standard are typically related to storm events, which are short-term in nature. Violations of the chronic criteria are typically associated with point sources or non-point source continuous discharges (e.g., leaking septic systems) and typically occur during all weather conditions. Targeting the acute criteria should be protective of the geometric mean criteria (i.e., chronic criteria). **The reduction calculated using the acute criteria is compared to the value calculated using the not to exceed percentage criteria, and the largest reduction is selected for the TMDL.**

5.4.2 Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time periods. Most violations occur during median to high flow conditions.

Critical conditions are accounted for in the load curve analysis by using the entire period of record of measured flows and all water quality data available for the stream. When continuous gages were not operational in a WBID, the expected range of flows in these streams was estimated using a weighted drainage area ratio.

5.4.3 Existing Conditions

Existing conditions are based on the instream water quality violations. When only a few samples exceed the numerical criterion, existing loads are based on the average values of the violations. In the load curve approach, the trend line equation is used to calculate the existing load at each duration interval. The loads between the 10^{th} and 90^{th} duration interval were averaged to obtain a single value. Flows occurring less than 10 percent of the time were considered extreme flood conditions while flows occurring greater than 90 percent of the time were considered extreme drought conditions. Extreme flow conditions were not considered in the TMDL analysis.

Using the trend line equation for fecal coliform in Falling Creek (see Figure 3), the calculated existing load between the 10^{th} and 90^{th} percentile ranges between 2.78×10^9 and 1.38×10^{12} counts/day. The average of these values, or 2.38×10^{11} counts/day, represents the total existing load in the stream.

Existing conditions for Camp Branch are based on instream concentration measurements violating the acute criteria. As shown in Appendix A, the average concentration violating the acute criteria is about 2118 counts/100ml. If only current data and data without data qualifiers are considered (i.e., data collected since 1995), the average concentration violating the acute criteria is about 2150 counts/100ml.

5.5 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In the Suwannee Basin TMDLs an implicit MOS was used. For TMDLs developed using load curves, allowable loads are based on the 400 criteria. In accordance with water quality standards this criterion is allowed to be exceeded 10 percent of the time. By assuming this criterion during all times represents a conservative assumption. In both the Camp Branch and Falling Creek TMDLs, the percent reduction represents the larger of the two values calculated from either the acute criterion (i.e., 800 counts/100ml) or the not to exceed criterion (400 counts/100ml).

5.6 Determination of TMDL, WLAs, & LAs

5.6.1 TMDL Values

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDLs are based on the one-day maximum concentration of the parameter as specified in the Class III WQS and are expressed in units of counts per day. The TMDL value is reduced by the WLA, if any, to obtain the LA component. TMDL components for the impaired waterbodies as well as the percent reduction required to achieve the numerical criterion are provided in Table 6.

Table 6. Coliform TMDL Components

Stream Name	Parameter	WLA[1]		LA (Counts/day)	TMDL[2] (Counts/day)	Percent Reduction[3]
		Continuous (counts/day)	MS4			
Falling Creek	Fecal Coliform	0	NA[4]	9.40×10^{10}	9.40×10^{10}	40%
Camp Branch	Fecal Coliform	0	NA	81%	81%	81%

Notes:

1. WLA component separated into load from continuous NPDES facilities (e.g., WWTP) and load from MS4. Continuous discharge facilities have WLA units of counts/day based on permit limits and design flow. MS4 load represented as

percent reduction. There are no NPDES facilities discharging fecal coliform in the watersheds nor are the watersheds in MS4 designated areas.

2. Margin of Safety is implicit and does not add to the TMDL value.
3. Overall reduction to achieve an instream water quality criterion of 400 counts/100ml for fecal coliform.
4. NA implies "not applicable".

5.6.2 Waste Load Allocations

There are no NPDES permitted facilities discharging coliforms to surface waters in either Falling Creek or Camp Branch. Future facilities permitted to discharge fecal coliform into the watersheds of these waterbodies will be required to meet end-of-pipe criteria equivalent to the water quality standard and not exceed the overall TMDL load, if known.

5.6.3 Load Allocations

There are two modes of transport for non-point source fecal coliform bacteria loading into the stream. First, loading from failing septic systems and animals in the stream are considered direct sources to the stream, as they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events.

5.6.4 Calculation of Percent Reduction

The percent reduction necessary to achieve water quality standards is based on the more stringent of the dual acute criteria. Insufficient data are available to calculate the reduction using the chronic criteria (i.e., geometric mean), but meeting the acute criteria should attain standards during all times. Calculation of the percent reductions for the coliform TMDLs is provided in Appendix B; an example using the load curve developed for Falling Creek is explained below. In the Falling Creek TMDL, the percent reductions are similar regardless of the criteria selected.

The fecal coliform TMDL for Falling Creek was developed using a load duration curve and the 400 criteria. The percent reduction is calculated as the average reduction required between the 10^{th} and 90^{th} duration interval. At each interval, the reduction is calculated between the allowable load and the existing load. The allowable load is calculated based on the 400 criteria and the flow at the particular interval. The existing load at each interval is calculated using the trendline equation (see Figure 3 for trendline equation). In the trendline equation the parameter "x" in the equation represents the duration interval and the parameter "y" represents the load. Table 7 details the calculation of the percent reduction for fecal coliform in Falling Creek.

Table 7. Calculation of Percent Reduction using Load Curve Approach for Fecal Coliform in Falling Creek (WBID 3477)

Interval	Allowable	Existing	% Reduction
95	7.54E+08	1.89E+09	60.0
90	1.11E+09	2.78E+09	60.2
85	1.48E+09	4.10E+09	63.8
80	3.01E+09	6.04E+09	50.1
75	6.53E+09	8.90E+09	26.6
70	1.23E+10	1.31E+10	6.2
65	1.88E+10	1.93E+10	2.6
60	2.76E+10	2.85E+10	3.1
55	3.77E+10	4.20E+10	10.3
50	5.02E+10	6.20E+10	18.9
45	6.53E+10	9.13E+10	28.5
40	8.29E+10	1.35E+11	38.4
35	1.06E+11	1.98E+11	46.8
30	1.38E+11	2.92E+11	52.8
25	1.76E+11	4.31E+11	59.2
20	2.29E+11	6.35E+11	64.0
15	3.01E+11	9.37E+11	67.8
10	4.35E+11	1.38E+12	68.5

Average loads and reductions between the 95th and 10th percentile:

Allowable Load =	9.40E+10	counts/day
Existing Load =	2.38E+11	counts/day
Reduction =	40.4	percent

As shown in Table 3, two samples collected in Falling Creek violated the 800 criteria and nine of the 65 samples violated the 400 criteria. The average reduction necessary to achieve the 400 criteria is about 40 percent (see Table 7). In evaluating the water quality data for TMDL development, violations with data qualifiers were not included in the analyses. The sample having the highest concentration without a data qualifier is 1400 counts/100ml. The reduction required to reduce this concentration to 800 counts/100ml is calculated as:

$$\% \text{ Reduction} = (1400 - 800) / 1400 * 100 = 43\ \%$$

The reduction required to achieve the 800 criteria is about the same as the 400 criteria; therefore the TMDL is based on the more stringent of the two criteria.

5.5.4 Seasonal Variation

Seasonal variation was incorporated in the load curves by using the entire period of record of flow recorded at the gages. Seasonality was also addressed by using all water quality data associated with the impaired streams, which was collected during multiple seasons.

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APPENDIX A - Water Quality Data

Table A- 1. Fecal coliform data collected in Fall Creek (WBID 3477) since 1995

Date	Station	Time	Depth	Result	Rcode	Flow	FSTREP	Fcoli:FSTRP ratio
2/7/95	21FLSUW FAL020C1	1416	0.82	22				
4/10/95	21FLSUW FAL020C1	1323	0.49	41				
8/7/95	21FLSUW FAL020C1	1240	0.82	96				
9/6/95	21FLSUW FAL020C1	1000	0.82	31				
11/13/95	21FLSUW FAL020C1	1023	0.82	140				
3/11/96	21FLSUW FAL020C1	1505	0.82	120				
5/13/96	21FLSUW FAL020C1	1526	0.00	220				
8/21/96	21FLSUW FAL020C1	953	0.49	110				
9/16/96	21FLSUW FAL020C1	1134	0.82	51				
11/18/96	21FLSUW FAL020C1	1048	0.49	160			82	2.0
1/28/97	21FLSUW FAL020C1	1343	0.82	68	B		34	2.0
5/9/97	21FLSUW FAL020C1	1514	0.49	27			23	1.2
8/12/97	21FLSUW FAL020C1	824	0.66	57			5	11.4
9/11/97	21FLSUW FAL020C1	1330	0.00	110			530	0.2
11/20/97	21FLSUW FAL020C1	1029	0.82	49	Q		3	16.3
1/7/98	21FLSUW FAL020C1	1429	1.15	60		36.3	3	20.0
7/27/98	21FLSUW FAL020C1	1547	0.66	110	B	4.52	240	0.5
8/10/98	21FLSUW FAL020C1	1456	0.49	310		1.72	410	0.8
11/16/98	21FLSUW FAL020C1	1307	0.66	10	B	0.93	32	0.3
1/18/99	21FLSUW FAL020C1	1022	0.00	57			34	1.7
2/1/99	21FLSUW FAL020C1	1155	0.00	133			210	0.6
5/16/99	FAL020C1			18				
7/14/99	21FLSUW FAL020C1	1621	0.00	80			510	0.2
8/10/99	21FLSUW FAL020C1	1330	0.00	550			570	1.0
11/10/99	21FLSUW FAL020C1	1328	0.00	190			300	0.6
2/14/00	21FLSUW FAL020C1	1451	0.00	480			290	1.7
5/11/00	21FLSUW FAL020C1	1252	0.00	46			310	0.1
2/14/01	21FLSUW FAL020C1	913	0.00	48			35	1.4
5/3/01	21FLSUW FAL020C1	1055	0.00	25			66	0.4
8/7/01	21FLSUW FAL020C1	1423	0.00	70	B		160	0.4
2/18/02	21FLSUW FAL020C1	1020	0.00	210			9	23.3
5/2/02	21FLSUW FAL020C1	1505	0.00	106			430	0.2
8/1/02	FAL020C1			320				
5/5/03	FAL020C1			320	P			
8/14/03	FAL020C1			80	P			

Note: Rcode are data qualifiers and have the following definitions:
P is too numerous to count
B is result based upon colony count outside the acceptable range
Q is sample held beyond normal holding time
K is off-scale low; actual value not known, but known to be less than value shown

Table A- 2. Fecal coliform data collected in Camp Branch (WBID 3401)

Date	wbid	sta	time	depth	result	rcode	FSTRP	Fcoli:FSTRP ratio
2/8/89	3401	21FLSUW CMP010C1	1800	0.49	1	K		
4/5/89	3401	21FLSUW CMP010C1	1210	0.66	560			
6/7/89	3401	21FLSUW CMP010C1	1130	1.15	2000			
8/9/89	3401	21FLSUW CMP010C1	1300	0.66	3700			
10/4/89	3401	21FLSUW CMP010C1	1415	0.98	1	K		
12/6/89	3401	21FLSUW CMP010C1	1405	0.66	200	P		
2/7/90	3401	21FLSUW CMP010C1	1535	0.66	290			
3/7/90	3401	21FLSUW CMP010C1	1723	0.66	160			
4/11/90	3401	21FLSUW CMP010C1	1430	0.98	150			
1/8/91	3401	21FLSUW CMP010C1	1310	0.66	160			
11/16/98	3401	21FLSUW CMP010C1	1134	1.15	60	B	200	0.3
1/13/99	3401	21FLSUW CMP010C1	1540	0.00	89		18	4.9
3/9/99	3401	21FLSUW CMP010C1	1617	0.00	58		11	5.3
11/10/99	3401	21FLSUW CMP010C1	1612	0.00	280		640	0.4
2/8/00	3401	21FLSUW CMP010C1	947	0.00	210		850	0.2
5/11/00	3401	21FLSUW CMP010C1	1156	0.00	19		170	0.1
8/9/00	3401	21FLSUW CMP010C1	1015	0.00	230		185	1.2
11/7/00	3401	21FLSUW CMP010C1	1531	0.00	72		23	3.1
2/12/01	3401	21FLSUW CMP010C1	1057	0.00	90		30	3.0
5/3/01	3401	21FLSUW CMP010C1	1446	0.00	120		101	1.2
8/1/01	3401	21FLA 21010054	0	0.20	1000			
8/21/01	3401	21FLSUW CMP010C1	1100	0.00	86		500	0.2
9/12/01	3401	21FLA 21010054	0	0.20	250			
2/12/02	3401	21FLSUW CMP010C1	1612	0.00	240		80	3.0
6/4/02	3401	21FLWQA 302213908253087	0	0.50	330			
6/4/02	3401	21FLWQA 302311808252393	0	0.50	245			
6/18/02	3401	21FLWQA 302209508253184	0	0.50	24			
6/18/02	3401	21FLWQA 302213908253087	0	0.50	2950			
6/18/02	3401	21FLWQA 302311808252393	0	0.50	2500			
2/11/03		CMP010C1			90	P		
5/8/03		CMP010C1			520	P		
7/30/03		CMP010C1			760	P		

Note: Rcodes are data qualifiers. See Table A- 1 for definitions.

APPENDIX B – Fecal Coliform TMDL Calculations

Table B- 1. Camp Branch samples violating fecal coliform water quality criteria of 400 counts/100ml

Date	wbid	sta	time	depth	result	rcode
4/5/89	3401	21FLSUW CMP010C1	1210	0.66	560	
6/7/89	3401	21FLSUW CMP010C1	1130	1.15	2000	
8/9/89	3401	21FLSUW CMP010C1	1300	0.66	3700	
5/8/03		CMP010C1			520	P
7/30/03		CMP010C1			760	P
6/18/02	3401	21FLWQA 302213908253087	0	0.50	2950	
6/18/02	3401	21FLWQA 302311808252393	0	0.50	2500	
8/1/01	3401	21FLA 21010054	0	0.20	1000	

As shown in Table B- 1, three samples collected since 1995 do not have data qualifiers and violate both the 400 and 800 criteria for fecal coliform bacteria. Flow data are not readily available on Camp Branch, and due to the relatively small drainage area of Camp Branch as compared to Deep Creek, where a continuous gage is located, it is not feasible to use a weighted drainage area to estimate flows. With the limited data, the TMDL is represented as a percent reduction necessary to achieve the water quality criteria of 400 counts/100ml. Existing, or current, conditions are represented as the average concentration of samples collected without data qualifiers that exceed the 400 criteria. Only samples collected since 1995 are considered to represent current conditions. The average concentration representing current conditions is 2150 counts/100 ml (i.e., 2950 + 2500 + 1000 / 3 = 2150).

The percent reduction is calculated using the following equation:

(Existing concentration – allowable concentration) / Existing Concentration * 100

The percent reduction required to achieve an instream concentration of 400 counts/100 ml is about 81 percent (i.e., (2150 – 400) / 2150 * 100 = 81.4%). To achieve an instream concentration of 800 counts/100ml, a 63 percent reduction is required (i.e., (2150 – 800)/2150 * 100 = 62.8%). The 400 criterion results in a more conservative TMDL and should allow water quality standards to be attained during other conditions.

Table B- 2. Fecal coliform samples collected in Fall Creek (WBID 3477) exceeding water quality criteria

Date	Station	Time	Depth	Result	Rcode
9/7/90	21FLSUW FAL020C1	1300	0.49	1400	
7/7/93	21FLSUW FAL020C1	1315	0.33	420	
11/10/93	21FLSUW FAL020C1	1425	0.98	460	
7/7/94	21FLSUW FAL020C1	1308	0.49	690	
6/6/95	21FLSUW FAL020C1	1120	0.82	440	
1/15/96	21FLSUW FAL020C1	1045	0.49	700	
3/17/97	21FLSUW FAL020C1	1511	0.43	550	
2/16/98	21FLSUW FAL020C1	1358	0.72	1850	B
8/10/99	21FLSUW FAL020C1	1330	0.00	550	
2/14/00	21FLSUW FAL020C1	1451	0.00	480	
		average violation:		**632.2**	

As shown in Table B- 2, only one sample that exceeds the 800 criteria does not have a data qualifier. To reduce this concentration of 1400 counts/100ml to 800 counts/100ml, a 43 percent reduction is required. As a check on the reduction prescribed using the load curve analysis, the reduction necessary to achieve the 400 criteria is calculated using the data violations presented in Table B- 2. The average concentration of the data values not having a data qualifier (i.e., Rcode) is about 632 counts/100ml. A 37 percent reduction would be necessary to reduce instream concentrations to 400 counts/100ml (i.e., (632-400)/632 * 100 = 36.7%). This reduction is similar to the value calculated using the load curve analysis.